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ECONOMIC ANALYSIS OF EFFLUENT GUIDELINES

INSULATION FIBERGLASS INDUSTRY

ENVIRONMENTAL PROTECTION AGENCY

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An analysis was made of the potential economic impact on the insulation fiberglass industry due to the implementation of the effluent limitations standards formulated in compliance with the 1972 Federal Water Pollution Control Act Amendments.

The capital costs of meeting the "Best Practicable Technology" and "Best Available Technology" provisions of the standards are estimated to be $10 million. Annualized effluent treatment costs are $3.1 million. The industry is not expected to suffer major adverse impacts as measured by loss of production, unfavorable price structure, employment curtailment, etc.

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Insulation Fiberglass; Insulation Fiberglass Industry; Best Available Control Technology; Best Practicable Control Technology; Economic Impact Analysis; Effluent Limitation Guidelines.

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ECONOMIC ANALYSIS

OF

EFFLUENT GUIDELINES

FOR THE

INSULATION FIBERGLASS INDUSTRY

January 1975

Office of Planning and Evaluation
Environmental Protection Agency
Washington, D.C. 20460

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PREFACE

The attached document is a contractor's study prepared with the supervision and review of the Office of Planning and Evaluation of the U.S. Environmental Protection Agency (EPA). Its purpose is to provide a basis for evaluating the potential economic impact of effluent limitations guidelines and standards of performance established by EPA pursuant to sections 304(b) and 306 of the Federal Water Pollution Control Act.

The study supplements an EPA technical "Development Document" issued in conjunction with the promulgation of guidelines and standards for point sources within this industry category. The Development Document surveys existing and potential waste treatment and control methods and technologies within this category and presents the investment and operating costs associated with various control technologies. This study supplements that analysis by estimating the broader economic effects (including product price increases, continued viability of affected plants, employment, industry growth and foreign trade) of the required application of certain of these control technologies.

The study is based primarily upon an earlier study entitled "Economic Analysis of Proposed Effluent Guidelines for the Insulation Fiberglass Industry" which was circulated in conjunction with the publication in the Federal Register of a notice of proposed rulemaking under sections 304(b) and 306 for the subject point source category. (That report, covering the insulation wool fiber glass industry, was excerpted from a report entitled "Initial Economic Impact Analysis of Water Pollution Control Costs Upon the Fiber Glass Industry." The aforementioned report included textile fiber glass industry in addition to the insulation wool fiber glass industry, and was submitted in fulfillment of contract no. 68-01-0767 by Arthur D. Little, Inc.; Cambridge, Massachusetts. Work was completed as of December 1972.) The analysis contained in the original study has been updated based upon information received during the period of time between publication of the notice of proposed rulemaking and the promulgation of the final regulation. Because of the constraints of time, the control and treatment costs analyzed in this study may not in all instances be identical to those associated with the requirements of the promulgated regulation. However, those differences, when they exist are minor insofar as the final conclusions of the study are concerned.

This report represents the conclusions of the contractor. It has been reviewed by the Office of Planning and Evaluation and approved for publication. Approval does not signify that the contents necessarily reflect the views of the Environmental Protection Agency. The study has been considered, together with the Development Document, information received in the form of public comments on the proposed regulation, and other materials in the establishment of final effluent limitations guidelines and standards of performance.

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EXECUTIVE SUMMARY

I. INTRODUCTION

The objective of this study is to provide an analysis of the economic impact of the water pollution control requirements anticipated for July 1977 and 1983 on the wool fiber glass industry (SIC #3296). Specifically, the economic impacts analyzed are:

- Price
- Profitability, growth and capital availability
- Plant shutdowns or production curtailment
- Employment
- Community
- Balance of Payment
- Related Industries

The information and data base for carrying out this analysis were developed principally from two sources: (1) our background and knowledge of and experience with the fiber glass industry, and (2) the assistance and cooperation of certain participating companies in the industry.

The present fiber glass industry was surveyed to establish the number, size and location of plants, as well as the specifics of the production technology. The present status of the industry in terms of markets, recent growth trends, future supply and demand and profitability levels were evaluated for each segment. The nature, type and degree of participation of the producing companies were also examined.

We then evaluated the estimated pollution abatement cost against the current prices and expected profitability of plants in the wool fiber glass industry. Correlating these effects with current performance and the future supply/demand projections, we analyzed the industry in order to identify if and where plant shutdowns and production curtailments might occur. The impacts on employment, community and such factors as balance of payments were also considered.

During our analysis we contacted several producers, both large and small, for information and concerns related to their experience in water treatment and opinions about the impact of the controls on the business. Again, at the conclusion of the analysis, we discussed the major conclusions and significant findings with some of the industries' executives.

We believe the information and data developed and the conclusions drawn represent a reasonably accurate picture of the economic effect of water treatment cost on the fiber glass industry. However, the many assumptions made in our analysis, although reasonable at this point in time, may not necessarily be valid for specific plant situations.

Because of the limitations of time and information available, this study is not to be considered definitive. It was intended to provide an indication of the kinds of impacts to be expected, and to highlight possible problem areas.

II. CONCLUSIONS

1. Financial Effects

- **Incremental Cost and Investment**

The cost of water pollution control (zero discharge - water recycle) in the wool fiber glass plant varies from 0.18 to 1.15¢/lb of glass wool produced. These costs are sensitive to the plant capacity and are of considerably greater significance for the smaller plant. The capital and operating cost effects for wool glass plants are summarized in Table S-I. The incremental cost as a percent of selling price spans a range of 0.64 to 3.8% for the range of existing plant sizes. The incremental capital investment cost of water pollution control is 1.3 to 3.8% of current plant investment.

- **Prices**

The incremental increase in cost due to water pollution control for glass wool products will be modest. It is unlikely that these increases in cost will be passed on independently in the form of price increases. However, if other operating costs increase concurrently, the cumulative total might become significant. Historically, the industry has offset cost increases by increased productivity.

- **Profitability**

The relative effects on company and plant profitability as a result of incremental cost increases due to water pollution abatement control are expected to be small. Assuming no price increase, those plants with

TABLE S-I

SUMMARY OF WATER POLLUTION CONTROL CAPITAL INVESTMENTS AND OPERATING COST FOR FIBER GLASS PLANTS

Plant Characteristics	Wool Fiber Glass			
Plant Capacity, MM lb/yr	440	90	20	5
Plant Output @ 80% Utilization MM lb	352	72	16	4
Net Revenues, $MM	98.5	1[illegible].7	4.4	1.2
Current Fixed Capital Investment, $MM	80	26	10	4
Water Pollution Control Cost				
Incremental Investment $MM	1.0-2.0	0.4-0.8	0.16-0.32	0.07-0.15
Incremental Investment as % of Current Investment	1.25-2.50	1.9-3.8	1.6-3.2	1.75-3.75
Incremental Annual Operating Cost, ¢/lb	0.18-0.19	0.27-0.19	0.44-0.50	0.93-1.15
Incremental Annual Operating Cost as % of Selling Price	0.64-0.68	1.04-1.11	1.57-1.78	3.10-3.83

current return on investment of 10-15% or greater will continue to enjoy good returns. Plants of any size with current ROI's of 5% or less would become marginal as the ROI's decrease below this level. However, we do not believe that any wool plants fall into this latter category.

- Capital Availability

The incremental investment cost for water pollution control, i.e., recycle, in wool glass plants is 1.25 - 3.75% of current plant investment and this amount will be expended over three years. Thus annual expenditures for water treatment and recycle are modest and will not have any significant effect on the normal capital expenditures of the major companies. The aggregate capital needs of the wool glass segment of the industry are estimated to be about $10 million, assuming that there are presently no treatment facilities. (However, 40% of the plants have in fact implemented water recycle treatment.)

The demands for capital expenditures within a company cannot be evaluated; however, we believe that the participating companies are committed to the fiber glass industry and that capital for water pollution control will be provided.

2. Production Effects

Presently, the wool glass industry is fully utilizing its capacity, and supply/demand projections (8%/yr) indicate that this will continue. The incremental operating and investment cost for recycling of machine cleaning, binder make-up, and cooling tower blowdown is not of sufficient magnitude to affect production in the face of the present and future demands. Although the smallest wool plant (5MM lb/yr) would face significant increased cost (3-4% of selling price), this particular facility is one of nine plants operated by the company and has a specialized function within the group. We conclude that no plant shutdown or production curtailment is likely to occur. In fact, there are plans by one major producer to increase capacities in spite of additional pollution cost.

3. Balance of Payment Effects

Exports of glass wool represent about 2% of domestic wool production and there are no reported imports. It is highly unlikely that this situation will change and certainly the small cost effect of pollution control will not influence import/export markets in any way. By and large, the export market is determined by a company's desire to develop a local market situation before building foreign plants to serve these markets.

4. Other Effects

Since there are no marginal operations in this industry segment that might be subject to shutdown or production curtailment, no effects on unemployment in the industry or secondary effects on communities or suppliers or customers are expected.

I. INDUSTRY SEGMENTS

In testing the sensitivity of the industry to the impact of water abatement treatment we have examined factors which differentiate plants in this industry segment. Such factors as production technology, plant size, location and age, and product may influence the overall impact that might occur.

For this industry segment we have used as a guideline the complete recycling of process water by July 1977. Although two treatment proceses are now in use in the industry, both meet the guidelines and are not significantly different in cost or performance.

1. Technology

Basically, the production of glass wool involves the melting of the raw materials batch to form a homogeneous glass, fiberizing the molten glass stream, and forming a random mat of fine fibers bonded together with a thermosetting phenolic binder. The resin is cured in low-temperature ovens and cut and packaged into the various product forms. (The technology of wool glass manufacture is described in the Appendix.)

In the wool glass industry there are different schemes for melting and feeding of glass (direct melt vs marble process) and alternative approaches to the fiberizing process (flame attenuation vs rotary spinning). Although there is some cost differential in the specific melting and fiber forming scheme utilized, some of these economics are offset by the product flexibility and speed. In general, there is a trend toward more use of direct melt process and rotary spinning fiber forming.

There are, however, no important ways in which the specific production technology employed in a plant influences either the rate and composition of plant waste water or the associated cost.

2. Plant Size

There is a wide range of capacities among the present glass wool fiber plants. There is a factor of about 80 between the largest (440MM lb/yr) to the smallest (5MM lb/yr). The largest number of plants (12) have capacities of 25-100MM lb/yr. The majority of plants are multiproduct operations producing home insulation, pipe duct, wool products, industrial insulation, etc. A relatively small number of plants produce a narrow product line, i.e., high-volume products, principally home insulation.

The major effect of plant size is the relationship of size to the incremental cost of water pollution control. Since these costs are not directly related to the capacity of the plant, smaller plants will bear a proportionally higher operating cost for abatement treatment than larger plants. The effect of plant size on the cost of water recycling is plotted in Figure 1. The spread reflects slightly different recycling systems. One plant has a rated capacity of <10MM lb/yr.

3. Plant Age

Wool plants span an age of from 2 years to more than 25 years since plant start up. About 30% of the plants are 10-15 years old while 25% are less than 10 years old, but time since start up is not necessarily a good guide to plant efficiency or profitability. All plants have undergone considerable upgrading of the production process and in many cases facilities have been expanded with installation of state-of-the-art processes. Any effects of plant age will be of more significance in the cost of installing water recycling systems. The situations are such that in specific plants changes in piping and construction are more difficult to undertake. These costs are difficult to generalize since each plant presents different problems in the location of treatment facilities and the exact new construction required.

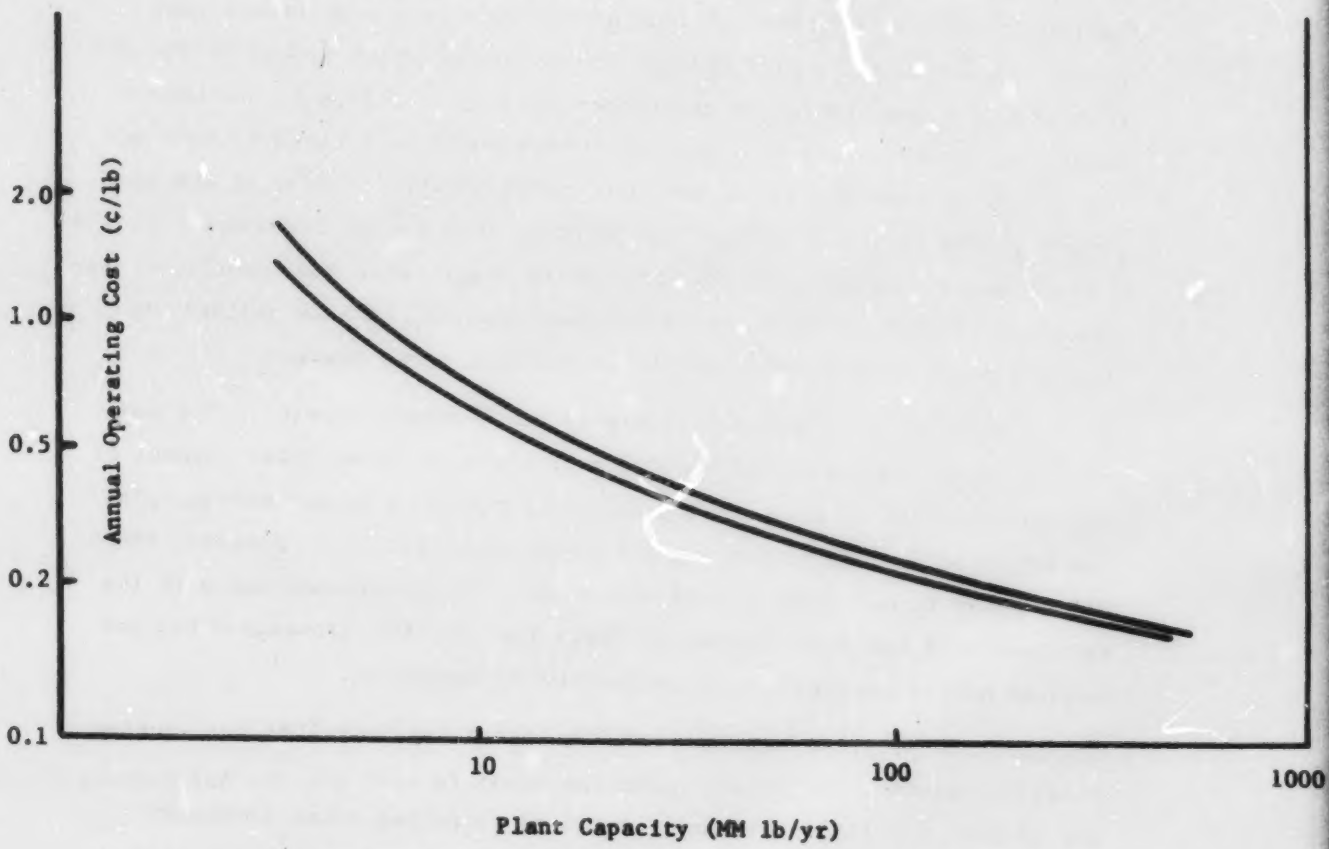


FIGURE 1 EFFECT OF PLANT SIZE ON COST OF WATER RECYCLING IN WOOL PLANTS

If we assume that the additional installation costs might be increased by 50% to cover additional construction and piping cost, we find that the effect is to increase the water recycling cost per pound of product in the older plants by 28% for the largest plant and by 18% for the smallest.

4. Plant Location

Glass wool plants in the United States are largely located near principal markets. Regional plants serve the principal population centers of the country, since the shipment of insulation would be a significant cost factor. There are no major changes in the market which appear to dictate that any of these plants are threatened because of shifts in the market. Rather, we would expect that new capacities would be located to take up any growth in specific areas, as illustrated by the location of the most recent plants in the Southeast and prior to that in the Southwest. In the future, major changes may take place which might raise the question of the viability of certain of these facilities; however, this is unlikely to happen within the projected period of the next three years.

In the analysis of plant sensitivity to the economic impact of the addition of water treatment and recycling in the wool glass fiber segment of the industry, we conclude that plant size and, to a lesser extent, plant age may be viewed as presenting different sensitivities. However, these differences appear to be relatively minor. In our discussions with the management of the major producers these factors were recognized but not seen as having any bearing on production or expansion.

Considerable progress has been made in installing recycling for machine cleaning, binder, and cullet quenching water in wool plants. Approximately 40% of the wool facilities have installed recycling water treatment facilities. Another 20% of the plants are discharging into municipal systems. We understand that the participating companies are committed to the installation of water recycling systems in this latter 20%. These two groups of plants produce more than 90% of the wool in the United States.

II. PRICE EFFECTS

A. Price Determination in the Fiber Glass Industry

Pricing in this industry sector is different for each of the three basic product groups.

The three basic product groups are:

- Building Insulation
- Architectural Products
- Industrial Applications

An understanding of the basic marketing and distribution strategies for each of these is required, as these strategies control and influence price determination.

For building insulation, all distribution channels are used. Companies will sell directly to major homebuilders, modular housing producers and mobile home manufacturers; they will also market to mass merchandisers and to building material wholesalers. Because of this variety of immediate customers, defining customer types and evaluating the qualifications of each for the appropriate prices and discounts can be a serious problem. Pricing in the building insulation sector is extremely competitive, is determined on a regional basis, and is sensitive to plant locations and resulting freight costs. There is little variation between the performance of the products supplied by the four companies competing for this market and, as fiber glass has largely been substituted for other types of minerals insulation in all uses, pricing can be extremely keen and will exhibit some elasticity.

Architectural markets, such as for roof insulation and acoustical ceiling tiles, is frequently on a specification and bid basis. Interindustry competition is greater than in most other glass fiber applications and thus the manufacturers' architectural representatives have the continued responsibility of maintaining contacts with the specifier and decision-maker and giving whatever technical assistance is required. Free market

pricing would naturally reflect these marketing costs but pricing decisions are frequently on a project-by-project basis and the bid price will depend on the amount of competition anticipated; sole source contracts are infrequent.

Industrial sales, such as for pipe, automotive and appliance insulations, are similar to textile glass fiber marketing. In this case, large volumes of material are involved and deliveries are required at a constant rate and on a predetermined schedule. Selling prices are negotiated directly between the two companies and will result in a contractual agreement covering a period of time, perhaps one year.

B. Price Trends

Prices for both building insulation and for industrial, pipe and equipment insulation have increased steadily over the past 10 years and currently stand at all time highs. The strong showing of residential construction especially has put great pressures on the availability of wool glass insulation and the industry has been allocating shipments to its customers. We can speculate that, assuming that no price controls had been in effect over the past 15 months, prices would have increased during this period and would have been an effective means of allocating available supplies.

C. Anticipated Price Changes Due to Pollution Control Requirements

Additional water pollution control costs may or may not be passed on to the customer in the form of increased prices, but a company or an industry is not likely to make such a decision in a vacuum. While additional costs can be directly attributable to increases in capital investment and cost of operations, the company must also consider its position relative to its competitors, the interrelated effects of other types of pollution control requirements and the economic environment in which it operates.

However, it is possible to make some preliminary estimates on operating costs as a percentage of selling price due to water pollution control requirements. These estimates are based upon control cost information developed by the economic contractor and restated by the EPA in the Development Document.

For wool glass fiber, the following average increments apply: (From Table II)

Plant Capacity (MM lb)	¢/lb	% of Selling Price
440	0.18	0.66
90	0.28	1.08
20	0.47	1.68
5	1.04	3.47

While there will be some variations in these values, depending on the type of water treatment adopted, the variations are small enough for them to be averaged. For a "typical" plant, the values will thus be 0.4¢/lb, or 1.5% on selling price. It is unlikely that any but the smallest of plants will pass on the increments in the form of price increases unless other increases in operating costs are also involved.

III. FINANCIAL PROFILES

Financial profiles for this industry are difficult to make, as almost all of the major manufacturers are fully diversified corporations, involved in a wide range of businesses and not willing to divulge confidential financial data on specific parts of their aggregates. In addition, while some reasonable attempts can be made to characterize the two principal segments, it is difficult to do so on a plant-by-plant basis; there is a wide range of sizes, ages, processes and product mixes.

Plant capacities in this sector range from 5 million pounds to 444 million pounds annually. The median capacity is about 50 million pounds. Dollar volume of sales ranges from approximately $1.2 million per plant to $110 million, with a median of about $15 million. Profits before tax on sales for wool glass plants have been good relative to textile fibers; they currently range from about 9% on sales before taxes to 20%, with a median of 12%.

As a percentage of manufacturing costs, the fixed portion for a larger plant is 60%, the variable, 40%. For a small plant, fixed costs represent 50%.

The actual investment required for an individual glass fiber facility will depend very largely on what pollution abatement there is and what is available from the city/municipal system. These investment costs can typically be amortized over a 10-year period before changes in technology demand a revision of operating standards and methods.

Few old plants and little obsolete equipment are in use in wool glass fiber production; therefore, the industry participants have valuable assets to protect, even if incremental investments are required. Whatever the amount, the smaller companies will find it a greater burden. One-half million dollars per facility may be of little significance to the larger companies, but one-hundred thousand may be a crippling amount for the smallest. The likelihood is, however, that incremental investments will be well within the financial capabilities of all participants.

IV. POLLUTION CONTROL REQUIREMENTS IN THE FIBER GLASS INDUSTRY

EPA has established effluent guidelines for the insulating wool segment of the fiber glass industry as "zero discharge" of waste water (except for non-contract cooling water which may be discharged) since the technology for total water recycle does exist and two different types of treatment systems (both allowing total water recycle) are in use by the two major manufacturers of insulating fiber glass wool. These guidelines apply to BPCTCA, BATEA, and NSPS.

Because the addition of advanced air emission control systems may increase the hydraulic and raw waste load to the point where these waste waters cannot be evaporated on the product without process changes, discharge limits for the significant pollutants have been established for BPCTCA where excess water is used for these purposes. This allowance for discharge from air pollution control devices is **not** contained in the 1983 (BATEA) standard, since the amount of time available for compliance with the 1983 standard is adequate to allow for process revisions to meet the no discharge standard. Similarly, no allowance is made for new sources since the options available to new plants include process modifications and plant siting.

Our estimate of the capital investment and operating cost for wool glass fiber is given in Table I. These costs were developed for recycle only since the requirements for treatment of excess discharge from air pollution control are highly uncertain across plants, especially given that some plants already include such waters in a closed cycle process water systems.

In estimating fixed capital investment, two specific designs of the treatment system were selected and scaled to a range of water flow rate spanning the plant sizes of interest. This data compared favorably to the experience of two producers who had installed similar systems. The operating costs were composed of estimates of operating and maintenance labor, chemicals and materials, and depreciation of the capital investment over 10 years.

TABLE I

ESTIMATED COST OF WASTE WATER TREATMENT FOR INSULATING FIBER GLASS WOOL MANUFACTURE

Plant Capacity (MM#/Yr)		Type Treatment System (A) Coarse Filtration Fine Filtration Water Recycle	Type Treatment System (B) Coarse Filtration Flocculation Settling Water Recycle
440	Fixed Cap.Investment($1000)	2000	1050
	Annual Operating Cost($1000)	610	680
90	Fixed Cap.Investment($1000)	800	400[1,2]
	Annual Operating Cost($1000)	200	200[3]
20	Fixed Cap.Investment($1000)	325[1]	160
	Annual Operating Cost($1000)	80	71
5	Fixed Cap.Investment($1000)	150	70
	Annual Operating Cost($1000)	46	37

1. Based on Costs reported by the industry
2. Actual investment was closer to $600,000 but the existing system has more capacity than required
3. Reported cost was closer to 0.3¢/lb, but reported treatment chemical cost seems high

V. IMPACT

A. Financial Effects

Table II summarizes the capital and operating cost effects of pollution control requirements on the wool glass fiber sector. These summaries are for selected plant capacities using estimates of revenues at 80% capacity utilization at assumed selling prices and at estimated current fixed capital investments. The increased costs will, in general, have only marginal effects on profitability and capital availability.

1. Profitability

The relative effects on company and plant pretax earnings, assuming no price increases as a result of the incremental operating costs, will be equal to the proportion of selling price represented by these costs. If incremental costs are passed on, the current rate of profitability will be maintained. As current returns on investment (ROI) are unknown for individual plants, the relative effects on ROI can only be obtained by assuming a certain level of profits on sales before taxes, and measuring sensitivity at various levels of ROI.

For this analysis, we assume average pretax earnings to be 12% on sales for wool glass fibers. The current ROI's tested are 5%, 10% and 15%.

For wool glass, a 1% increase in operating costs will reduce ROI's by 8.3% of the current rate.

The actual effects for the various plant capacities and types of treatment processes summarized in Table II is shown in Table III. Plants of any size in either segment that currently have an ROI no better than 5% will become marginal and could possibly cease production. However, we believe that no such facilities exist. Plants operating at over 5% ROI will continue to enjoy reasonable return.

TABLE II

SUMMARY OF CAPITAL AND OPERATING COST EFFECTS: WOOL GLASS FIBER

Plant Capacity (MM lb)	Type of Treatment Process	Plant Output (MM lb)	Net Revenue ($MM)	Current Fixed Capital Investment ($MM)	Water Pollution Control Costs			
					Incremental Investment ($MM)	Incremental Investment as % of Current Investment	Incremental Operating Cost (¢/lb)	Incremental Operating Cost as % of Selling Price
440	(A) Coarse and Fine Filtration	352	98.5**	80	2.0	2.5	0.18	0.64
	(B) Flocculation and Settling	352	98.5	80	1.0	1.25	0.19	0.68
90	(A)	72	18.7***	26	0.8	3.8	0.27	1.04
	(B)	72	18.7	26	0.4	1.9	0.29	1.11
20	(A)	16	4.4**	10	0.325	3.25	0.50	1.78
	(B)	16	4.4	10	0.16	1.6	0.44	1.57
5	(A)	4	1.2****	4	0.15	3.75	1.15	3.83
	(B)	4	1.2	4	0.07	1.75	0.93	3.10

* @ 80% Yield

** @ 28¢/lb

*** @ 26¢/lb

**** @ 30¢/lb

TABLE III

EFFECTS ON ROI: WOOL GLASS FIBER

Plant Size (MM lb/yr)	Waste Water Treatment Type	Operating Cost as % of Selling Price	New ROI if Currently 5%	10%	15%
440	A	.64	4.7	9.5	14.2
	B	.68	4.7	9.5	14.2
90	A	1.04	4.6	9.2	13.7
	B	1.11	4.5	9.1	13.6
20	A	1.78	4.3	8.5	12.8
	B	1.57	4.4	8.7	13.0
5	A	3.83	3.4	6.8	10.2
	B	3.10	3.7	7.4	11.1

2. Capital Availability

For wool glass, incremental investment as a percentage of current investment equates to an aggregate range of from 1.25% to 3.8%, or an annual average of 0.4% to 1.3% of current plant investments. However, most of the wool glass facilities already have implemented much of the required controls. Maximum expenditures will range from $70,000 to $2 million, with a mediam of approximately $450,000.

The question of whether sufficient capital will be available to meet the timetable and requirements of water pollution control is basically one of intra-company needs. Naturally, the exposure of the smaller companies, will be greatest but it is unlikely that the aggregate capital needs by the industry segments (about $10MM) will have any significant effect on the normal capital expenditures of the major companies. (See Table IV.)

We estimate that the greatest capital requirement on an average annual basis by any one of these five companies will be about $3 million, ranging to a low of $150,000. On this basis, the proportion of normal capital expenditures for the five major companies would range from 1% to 7% of 1971 expenditures annually for three years, and we believe this is not unreasonable.

TABLE IV

CAPITAL EXPENDITURES BY MAJOR CORPORATIONS, 1969 - 1971

($MM)

	1969	1970	1971
PPG	110.7	153.2	123.5
OCF	63.8	33.0	39.3
JM	39.3	44.7	48.8
Ferro	8.9	6.1	5.3
C-T	11.7	9.6	12.9
Total ($MM)	234.4	246.6	229.8

Average Annual Expenditure $237 MM

Sources: Company Annual Reports

However, such an evaluation cannot be truly made in ignorance of other demands for capital expenditures within a company, and the final decision will obviously depend on the degree of commitment each company has to the glass fiber industry. According to our conversations with the executives of many of the major companies, and also of the smaller ones, we understand that there is such a commitment and that capital for water pollution control requirements will be provided so that each company, at the very least, will continue its current level of involvement.

B. Production Effects

The economic impact of the cost of installing and operating complete recycling systems for machine cleaning, binder make-up water, and cooling tower blowdown should not have a major effect on plant shutdown or production curtailment. For all existing plants the additional cost of recycling is less than about 1¢/lb of product; although for the smallest plant size (5MM lb/yr) the increased cost is 3-4% of the selling price. It appears that the increase in cost of producing wool glass will be absorbed by the producer without significant effects. In these computations of cost we have not taken into account savings in binder cost due to recycling of binder make-up water. The experience of the industry is varied; however, any savings could only minimize this small cost increase. There is only a single plant operating in the capacity range of <5MM lb/yr and this plant, one of nine plants operated by the company, is utilized for pilot operation and specialty products. Because of this it is doubtful if the cost of recycling waste water would precipitate shutdown. This particular plant represents less than 0.3% of the industry capacity.

Presently, the wool glass industry is enjoying full utilization of its capacity and it is likely that this trend will continue. The future market projection indicates that the demand for glass wool products should grow at about 8% per year for at least the next five years. In the face of this market situation, it is highly unlikely that production will be curtailed or plants will be shutdown due to the modest investment and cost of water recycling.

C. Employment Effects

It is anticipated that plant shutdown and production curtailment will not result from the initiation of water pollution control in the wool glass fiber industry. In light of the projected market demand and the high utilization of capacities, it is doubtful that there will be unemployment in the industry. In fact, small increases in employment by the industry might take place as markets grow and additional personnel are required to operate water treatment facilities.

D. Community Effects

Based on the conclusion that no major plant shutdown, production curtailment, or unemployment will result in the wool glass fiber industry, there will be no effects on any community.

E. Balance of Payment Effects

U.S. exports and imports of glass fibers represent a very small portion of the total shipments. Imports, all textile-grade yarn, are of relatively little significance, and while exports have been as high as 7% of U.S. shipments, there is little reason to expect any change. Wool glass exports were less than 2% of wool production.

By and large, the imports-exports are not expected to change from recent past years. Fiber glass is not a product that can generally be shipped widely to meet local competition. Furthermore, we do not see that the very modest increase in cost due to water pollution control could have any impact on the export-import situation.

VI. LIMITS OF THE ANALYSIS

In carrying out our analysis of the economic impact of water pollution control on the fiber glass industry, we made some general assumptions about the economy in general and specific assumptions about the industry itself. For instance, we assumed that real growth in Gross National Product will average about 4% per year between 1972 and 1976.

We believe that this analysis represents an accurate description of the economic effect of the cost of pollution on this industry in terms of the conclusions drawn. Of course, there are a number of factors such as specific companies' commitments to the business which one must assume.

For the wool fiber glass industry, the capital investment reported by the industry is 10-50% higher than we have estimated. The main reason for this is the degree of modifications required by these systems after they were first constructed. We believe that if these systems were constructed today on the basis of the operational data now available, the capital investment would be closer to our estimate. We believe this is a valid rationale, since the impact of the pollution abatement requirements will be most felt by those mills that do not have adequate waste water treatment rather than those that do.

The effect of the higher capital investments (10-50%) would at most result in a 10% increase in operating cost, not significant enough to affect our conclusions.

There is a wide variation in labor and chemical costs reported by the industry for waste water treatment; therefore, we were reluctant to use

some of the figures reported by the industry as being representative. Our estimates of total operating costs are lower -- by as much as 30% -- than those reported by industry.

Our capital investment estimates (Section IV) pertain to the waste water treatment system only, not to plant modifications required for the collection of the waste water. In some cases, the cost of the additional piping will run as high as 50% of the cost of the treatment system itself. The exclusion upon promulgation of non-contact cooling water from the regulation has the effect of decreasing the initial cost estimates slightly The effect is variable and is not expected to involve a cost decrease of greater than 10 percent.

In cases where the waste water is only partially treated (e.g., by coagulation and clarification with or without aerated lagoon treatment) and discharged to a municipal sewerage system, the capital cost of tie-in can run as high as the total cost of the preliminary treatment system at the mill. However, the combination of pretreatment costs and sewerage charges is not likely to run as high as total on-site treatment at the mill.

As stated previously, some treatment or process modification to meet air emission standards may be required for some plants. Because of the variability in the situations facing individual plants and the options available to them, the precise effect on the baseline economic analysis has not been determined. In one case the maximum additional impact has been calculated to ba an almost 50% higher capital cost if the air emission control wastes are treated biologically rather than if that volume were included in the recirculation system, as is done by the rest of the industry.

A similar situation might occur if new products are developed which require different coating systems and these systems might produce water pollution problems not amenable to the treatment system presently being considered for fiber glass plants.

Finally, the future situation regarding the availability of energy for the industry might create a serious problem if energy sources become in short supply. It is paramount to the operation of existing plants as well as future expansion that adequate energy (electricity, oil and gas) be available to maintain furnaces at operating temperatures.

VII. APPENDIX - INDUSTRY DESCRIPTION

A. Demand for Glass Fibers

This section discusses the historic demand for glass fiber; the importance of the export market; production applications; and the influence of government on market demand. The methods of marketing and distribution, important factors in product pricing, have been discussed earlier.

Table V shows U.S. shipments and value for wool glass fiber in the period 1964-1971. The growth of wool glass fibers has been at an annual rate of 7% to 1518 million pounds, but sales have increased from $227 million to $427 million in this period.

Wool glass fiber growth will average at least 8% annually to 1977, but with batt insulation growing at 10% per year through 1974 and averaging 7% over the 5 years. Total shipments will thus be over 2.3 billion pounds for wool glass.

Table VI shows the U.S. exports and imports of glass fiber in the years 1969 - 1971. It is evident that imports, restricted to textile grade yarn and mostly from Japan, are insignificant and will not be stimulated by any marginal changes in U.S. product selling prices resulting from the implementation of water pollution control requirements.

TABLE V

U.S. SHIPMENTS AND VALUE OF WOOL GLASS FIBER 1964-1971

Insulation Use	1964			1965			1966			1967		
	MM lb	$ MM	¢/lb	MM lb	$ MM	¢/lb	MM lb	$ MM	¢/lb	MM lb	$ MM	¢/lb
Structural Building	368	76	20.7	438	93	21.1	484	105	22.6	484	109	22.5
Industrial, Pipe & Equipment	570	151	26.5	608	158	26.0	608	173	28.5	554	170	30.7
Total	938	227	24.2	1046	251	24.0	1072	278	25.9	1038	279	26.9

Insulation Use	1968			1969			1970			1971		
	MM lb	$ MM	¢/lb	MM lb	$ MM	¢/lb	MM lb	$ MM	¢/lb	MM lb	$ MM	¢/lb
Structural Building	557	133	23.9	627	158	25.2	644.8	165.6	25.7	--	--	--
Industrial, Pipe & Equipment	567	179	31.6	675	198	29.3	541.5	190.6	35.2	--	--	--
Total	1124	312	27.8	1302	356	27.3	1186.3	355.8	30.0	1518.7	426.9	28.2

Note: Values are average manufacturers' net selling prices, f.o.b. plant, after discounts and allowances, and excluding freight and excise taxes.

Source: Department of Commerce "Current Industrial Reports"

TABLE VI

U. S. EXPORTS OF GLASS FIBER, 1969 - 1971

	1969		1970		1971	
	MM lb	$MM	MM lb	$MM	MM lb	$MM
Textile Grade						
Yarn	5.0	3.0	11.8	5.8	6.1	3.5
Roving and Strand	6.1	2.2	15.9	5.0	6.7	2.7
Mats	--	1.2	--	1.4	--	2.2
Other	--	1.3	--	1.3	--	1.4
Total	--	8.7	--	13.5	--	9.8
Wool Grade - Total	--	7.4	--	7.2	--	8.4

Source: U.S.Department of Commerce FT 610

U. S. IMPORTS OF GLASS FIBER, 1969 - 1971

Textile Grade Yarn	1.4	0.4	0.7	0.6	1.8	0.7

Source: U.S.Department of Commerce FT 135

1. Wool Glass Markets

Wool glass fiber is used primarily as a building insulation (in batt form for frame house walls and roofs and as boards for flat roofed commercial and industrial buildings) and also in acoustical ceiling tiles, heating and cooling pipe and duct insulation, and in process equipment and appliance insulations. No industry data of the breakdown in consumption exists but we estimate the following for 1971 (MM lb).

ESTIMATE OF U.S. CONSUMPTION OF
WOOL GLASS FIBER, 1971

Batt Insulation	1000
Acoustic Tiles	90
Board Insulation	175
Pipe, Appliance and Equipment	165
Miscellaneous	60
Total	1490 MM lb

The major use of building insulation is in the residential sector in both conventional construction and mobile homes. Here it competes against other forms of mineral wool but has an estimated 90% of the insulation market. Building insulation in board form competes against perlite and an increasing amount of urethane and other foams, although the latter products are still not cost competitive with fiber glass. In non-residential construction (especially for roof decking) insulations can be either glass fiber, wood fiberboard, Tectum, lightweight concrete or gypsum, perlite board, foam glass and ceramic insulation materials. Fiber glass thus receives much greater competition in the non-residential sector than in housing construction and as a result has only a relatively small market share.

Acoustical tile insulation is predominately aimed at the non-residential sector, particularly for stores, classrooms, offices, laboratories and government buildings. Roof tile, by tradition, has been made from wood fiberboard although this market is seriously challenged by the fire

problems associated with wood fiber. Increasingly, such products are made from gypsum wallboard and, to a lesser extent, glass fiber.

Glass fiber use in industrial and equipment insulation includes the wrapping of chemical and process piping, lining of the galvanized surfaces of heating and air conditioning distribution ducts, insulation of water heaters and many miscellaneous other applications. The principal competition facing fiber glass is from urethane and styrene materials up to 250°F and calcium silicate in the high temperature ranges.

Future growth of this product segment will be better than the growth rate of U.S. building construction. Thus, the growth of products largely serving the non-residential building sector (acoustic tiles, board insulation, pipe, appliance and equipment insulation) will be at the average rate of 5% to 6%. Batt insulation, the major product, will experience a rate of growth of up to 10% per year for 1973 and 1974 due to the increased demand brought about by changing insulation regulations and energy conservation policies (these are discussed later). This rate of growth is considerably faster than that anticipated for residential construction but will not be sustained beyond 1974. In fact, we forecast the average rate of growth of batt insulation in the period 1971 to 1977 to be about 8%, as will be that of all wool glass fiber products.

2. Government Influence on Demand

The principal federal government influence on demand is brought about through changes or modifications in building code requirements. Such a change took place recently when the Department of Housing and Urban Development, Federal Housing Administration, revised the Minimum Property Standards for multi-family and single-family housing in order to fulfill the Department's commitments to the National Energy Conservation policy. The revisions, which took effect in July 1971 for single-family construc-

tion and in June 1972 for multi-family construction, went into effect immediately for all mortgage insurance projects for which a letter of feasibility had not been issued and for low rent public housing projects for which a program reservation had not been issued. This implementation will definitely provide more economical operating costs for the heating of residential units and will also conserve the nation's energy resources.

The effect of such a policy change is to increase considerably the use of and demand for building insulations of all types but principally the glass fiber batts. Quantification in terms of increases in usage rates is difficult to make as it depends very largely on the part of the country in which a particular structure is located, on the balance between federal program housing and that privately financed in each locality, and on the rate at which non-federal housing will follow suit at the urgence of electrical utilities. However, we did estimate earlier the approximate growth rate of demand resulting. This could be understated if, for instance, tax incentives are given to improve building insulation and conserve energy.

(A move which will have similar effect, although not resulting from the direct influence of the Federal Government, is the change in mobile home insulation requirements recently implemented by the Mobile Home Manufacturers' Association and will take effect in units shipped to 38 states beginning the first quarter of 1973. This change is designed to improve the insulation performance of mobile homes to match those of conventional construction.)

B. Supply

1. Industry Structure

a. Fiber Glass Wool

1) Production Technology

A flow sheet of an operation for the production of glass wool insulation is shown in Figure 2. The basic raw material batch and melting is essentially the same as the textile fiber glass industry. By and large the melting technology has followed the same trends as the textile segment,

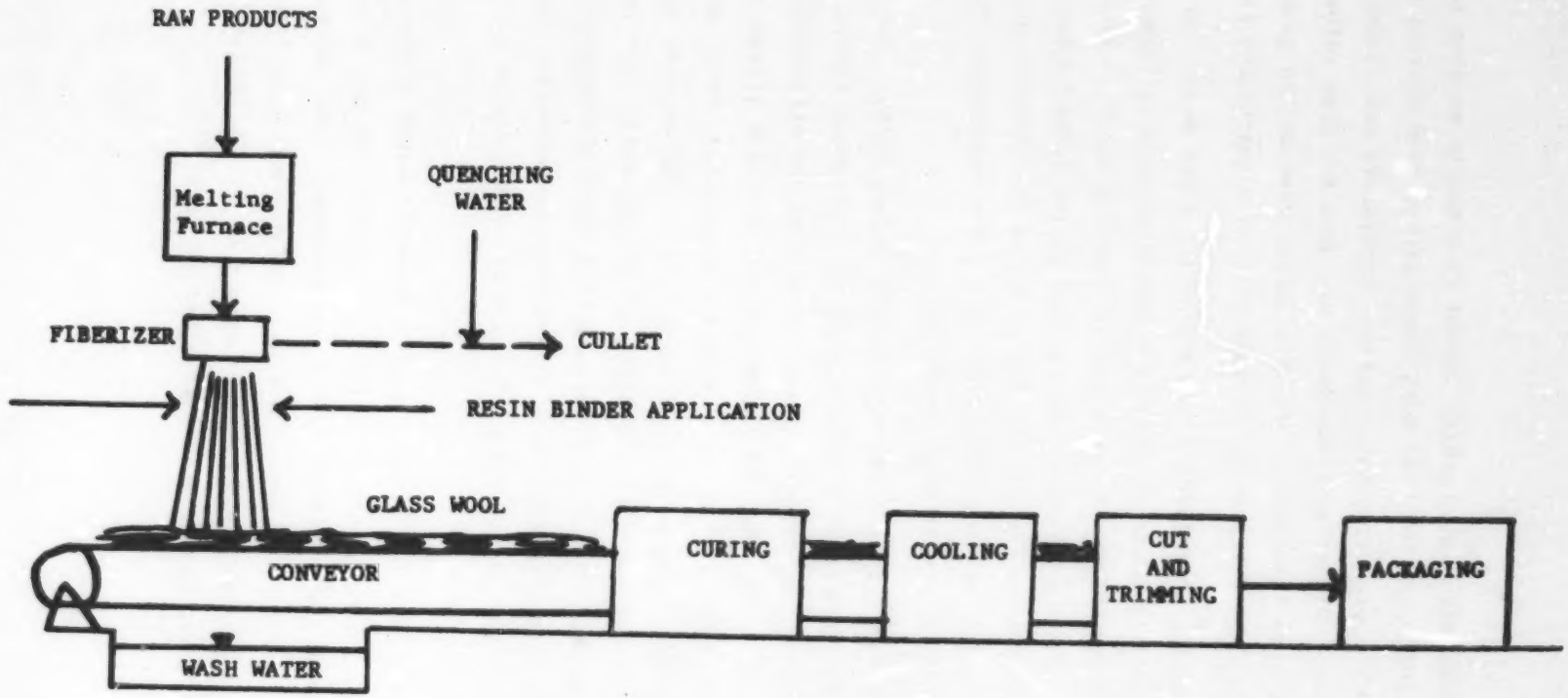


FIGURE 2 PROCESS DIAGRAM - GLASS WOOL

i.e., some operations use glass marbles formed in a marble machine to feed the fiber making operation. In most cases marble feed operations are limited to special products, i.e., battery separators and electrical equipment insulation. Direct melt processes are used for high volume production such as home insulation. In this latter case molten glass from the furnace is fed to the fiber forming unit in a continuous stream.

There are a variety of fiber forming operations for glass wool. In all cases a stream of molten glass is fiberized and attenuated to form discontinuous fine fibers which are collected on a moving conveyor belt in a continuous mat. Phenolic binders are sprayed on the formed fibers just prior to collection. The mat is then cured as the conveyor moves through an oven. Fiber forming rates and chain speed determines the density and thickness of individual products.

There are two principal fiber forming processes in use today. The first method involves the forming of a large number of individual fibers from a platinum bushing and the primary fibers are heated and attenuated by high velocity gas burners. In the second process a single stream of molten glass is fed into a rotating platinum distribution basket which distributes the glass on an outer rotating spinner. The spinner contains a large number of small holes arranged in rows in the wall. The molten glass is forced through the holes forming fibers which are then attenuated 90° from their forming direction by high velocity gas burners. The output of a single spinner may be 500-1000 lb/hr and several spinners are used to feed fiber to one line.

The discontinuous fibers are sprayed with a phenolic water binder and drawn to suction onto the conveyor chain. The continuous mat is cured in the in-line ovens and compressed, cut and packaged. The continuous chain returns to the forming area. A single machine may have fiberizing rates of 8,000-14,000 lb/hr and conveyor speeds of 50-200 lineal ft/sec. A description of glass wool products is given in Table VII.

TABLE VII

PRIMARY FIBROUS-GLASS-WOOL PRODUCTS

Product	Nominal Fiber Diameter, In.	Density Range, Lb per Cu Ft	Conductivity, 75°F, Mean, Btu/(Hr)(Sq Ft)(°F)/(In.)	Binder	Maximum* Temperature Limit, °F	Major Applications
Unbonded wool ("white")	0.0005	1.5 up (3.0 std)	0.30–0.27	Oil only	1000	Heated equipment and appliances
Bonded wool (molded)	0.00038		0.25 @ 100°F mean	Phenolic resin	400	Pipe insulation—low-temperature and low-pressure heated pipe
Bonded wool	0.00034	1.5–3.75	0.26–0.23	Phenolic resin	400	Appliance insulation
Bonded wool	0.0005	2.0–3.75	0.28–0.25	Phenolic resin	400	Appliance insulation
Bonded wool	0.0006	6.0	0.24	Phenolic plus high-temp resins	600	Duct insulation—fire-barrier insulation
	0.0006	2.0–12.0	0.29–0.24	Phenolic resin	400	General purpose and fabricated forms: rolls, batts, blocks, boards (plain, faced, asphalted), metal-mesh blankets; duct insulation, pouring wool
Bonded wool (fine fiber)	0.00004	0.6	0.23	Phenolic plus high-temp resins	600	Aircraft insulation
Bonded wool	0.00008	0.5		Phenolic resin Silicone oil		Flotation application
Bonded wool (fine fiber)	0.00012	0.75–2.0	0.27–0.22	Phenolic plus high-temp resin	600	Wrapped-on-pipe insulation
	0.00012	0.75–2.0	0.27–0.22	Phenolic resin	400	General-purpose insulation—sound control—shock cushioning
	0.00012	0.3–0.5		Phenolic resin Silicone oil		Clothing interliner Seat cushioning
Bonded wool (fine fiber)	0.00017	0.75–2.0	0.29–0.24	Phenolic resin	400	Railroad-car, truck-trailer, and furnace insulation
Basic fine Fibers (bulk)	0.00002 0.00012 (½–3 μ)			Unbonded Unlubricated		Fibers for papermaking

* Maximum surface temperature in contact with insulation under most favorable conditions. Organic lubricants and binders begin to oxidize from hot surface at 275°F. Actual loss of organic material depends on amount present, access to oxygen, and thickness and density of insulation. There is no low-temperature limitation so far discovered down to −300°F.

2) Number and Location of Firms and Plants

In the United States there are 19 plants producing glass wool products. There are two major producers of glass wool, Owens-Corning Fiberglas and Johns-Manville, and these two firms produce approximately 95% of the production in fifteen plants. There are really no small producers of glass wool since this is a high volume production operation, difficult to scale down.

The location of the 19 plants are shown in Figure 3. The distribution of plants is dictated by regional markets and plants must be near the end-use market. It is evident from the map that plants are located near major population centers to serve the building industry. The participating companies and their plant locations are also given in Table VIII.

It is anticipated that new capacity will be added to the present wool production in the near future. One firm, Johns-Manville, has announced a program of plant expansion and new plant construction that might add as much as 40% to the company's capacity.

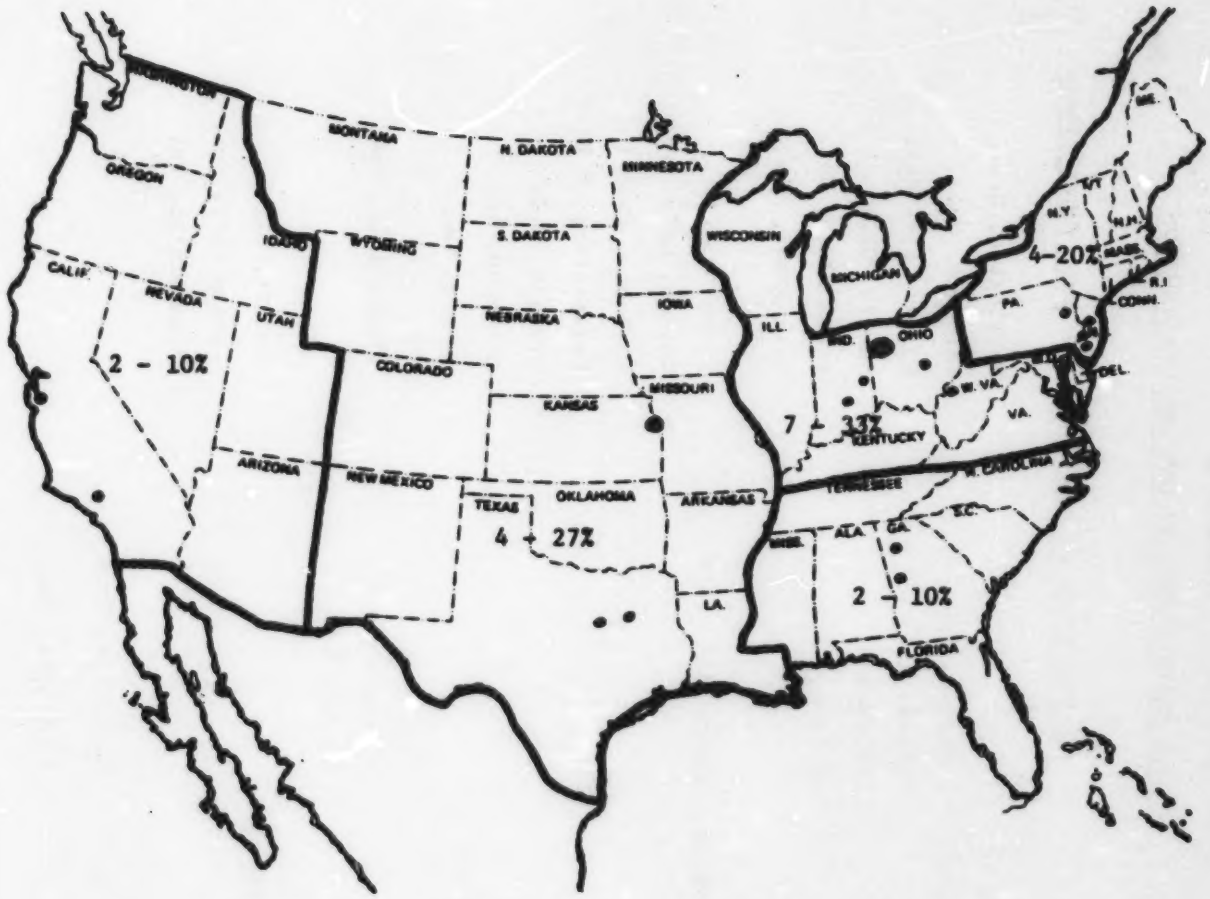
3) Types of Firms

Glass wool production is also dominated by Owens-Corning, the leader in textile glass as well. The remaining portion of the industry is shared by Johns-Manville, Certain-Teed and PPG Industries. All these firms are relatively large companies with integrated product lines. There are no small producers of glass wool products.

4) Types of Plants

The distribution in sizes of glass wool plants are shown graphically in Figure 4. The four plants with capacities greater than 100MM lb/yr account for ~70% of the production of wool and the largest number of plants are clustered around the 50MM lb/yr capacity. The larger plants tend to be more efficient especially in the high volume products such as home insulation. The industry is operating at 100% capacity at the present time and these high operating rates are expected to continue.

Plants can be differentiated by the type of process. Ten of the 19 plants utilize rotary spinners for fiber forming. In all these plants direct melt



N - %

N = Number of Plants in Area

% = % Total Capacity of Plants in Area

FIGURE 3 DISTRIBUTION OF GLASS WOOL PLANTS IN THE UNITED STATES

TABLE VIII

FIBER GLASS PLANTS BY COMPANY AND LOCATION

Company	Textile Fiber Plants	Wool Fiber Plants
Owens-Corning Fiberglas, Inc.	Aiken, S.C.	Barrington, N.J.
	Anderson, S.C.	Fairburn, Ga.
	Ashton, R.I.	Kansas City, Kan.
	Huntingdon, Pa.	Newark, Ohio
	Jackson, Tenn.	Santa Clara, Cal.
		Waxahachie, Tex.
Johns-Manville	Waterville, Ohio	Cleburne, Tex.
		Corona, Cal.
		Defiance, Ohio (3)
		Parkersburg, W.Va.
		Penbyrn, N.J.
		Richmond, Ind.
		Wender, Ga.
PPG Ind.	Lexington, N.C.	Shelbyville, Ind.
	Shelby, N.C.	
Certain-Teed		Berlin, N.J.
		Kansas City, Kan.
		Mountaintop, Pa.
Ferro Corp.	Nashville, Tenn.	
Kaiser	Irwindale, Cal.	
(Modiglass Fibers) Reichold Chem.	Bremer, Ohio	
Fiberglass Ind.	Amsterdam, N.Y.	
United Merchants	Statesville, N.C.	
Oliver Glass Fiber	Farmingdale, N.Y.	

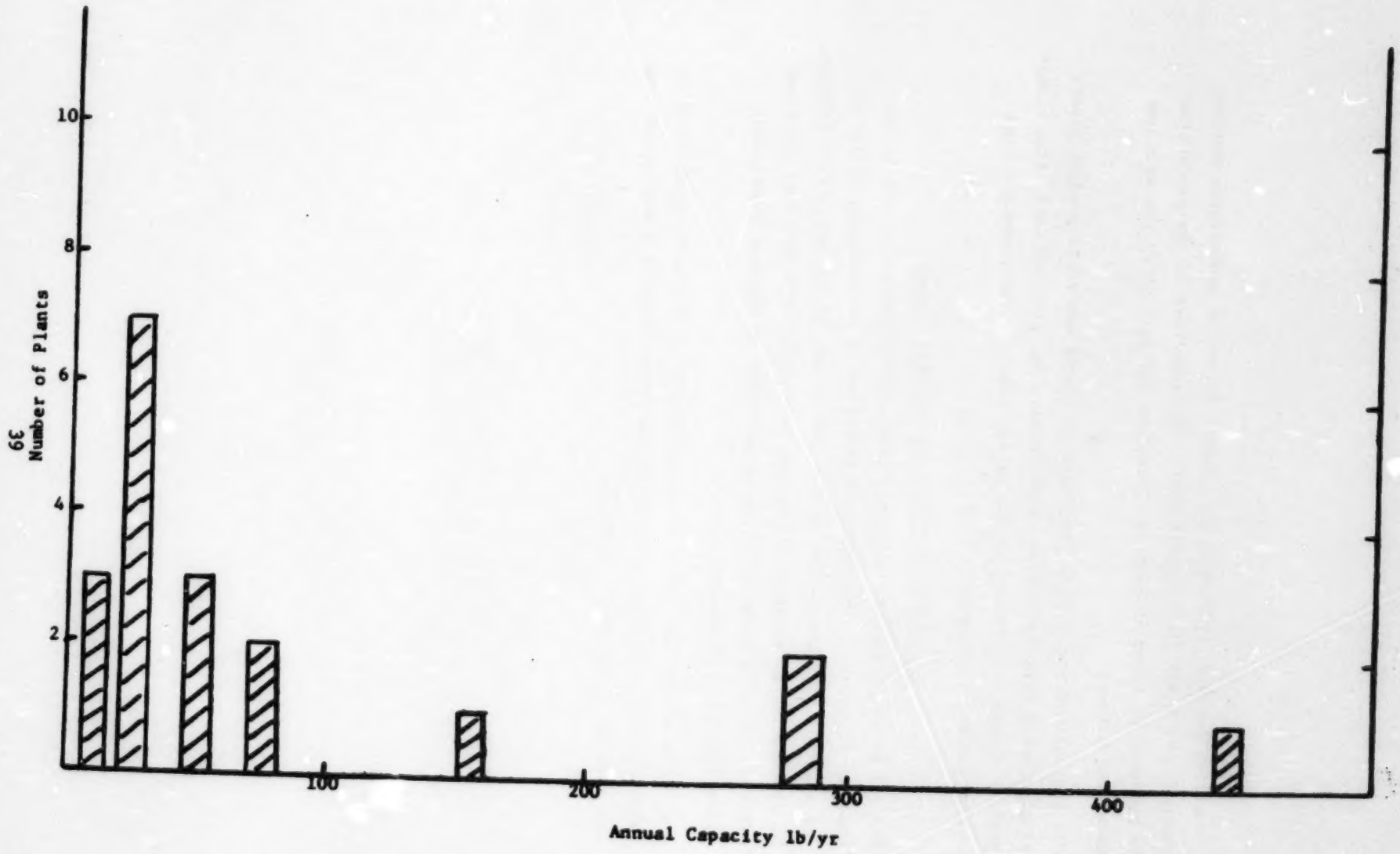


FIGURE 4 SIZE DISTRIBUTION OF GLASS WOOL PLANTS

techniques are used to supply the glass. Rotary or centrifugal process accounts for ∿ 80% of the glass wool. The remainder of the production is produced by flame attenuated fiberizing fed by both direct melt and marble techniques.

All indications are that the majority of plants are multi-product plants manufacturing home insulation, roof insulation, pipe and duct, etc. Single product plants are limited to one or two plants which produce a high volume product -- home insulation.

5) Number of Employees and Skill Level

The number of production employees from a cross-section of plants are shown in Figure 5. The number of employees is surprisingly scaled to the plant size. This is due to the line nature of the production process. Plant capacity is related to the type and number of individual lines and although there is a variation in product type at various plants most operations are multi-product.

The degree of skilled labor required is high in the melting and forming area; however, the large portion of the labor force in a wool plant does not require a high level of skill.

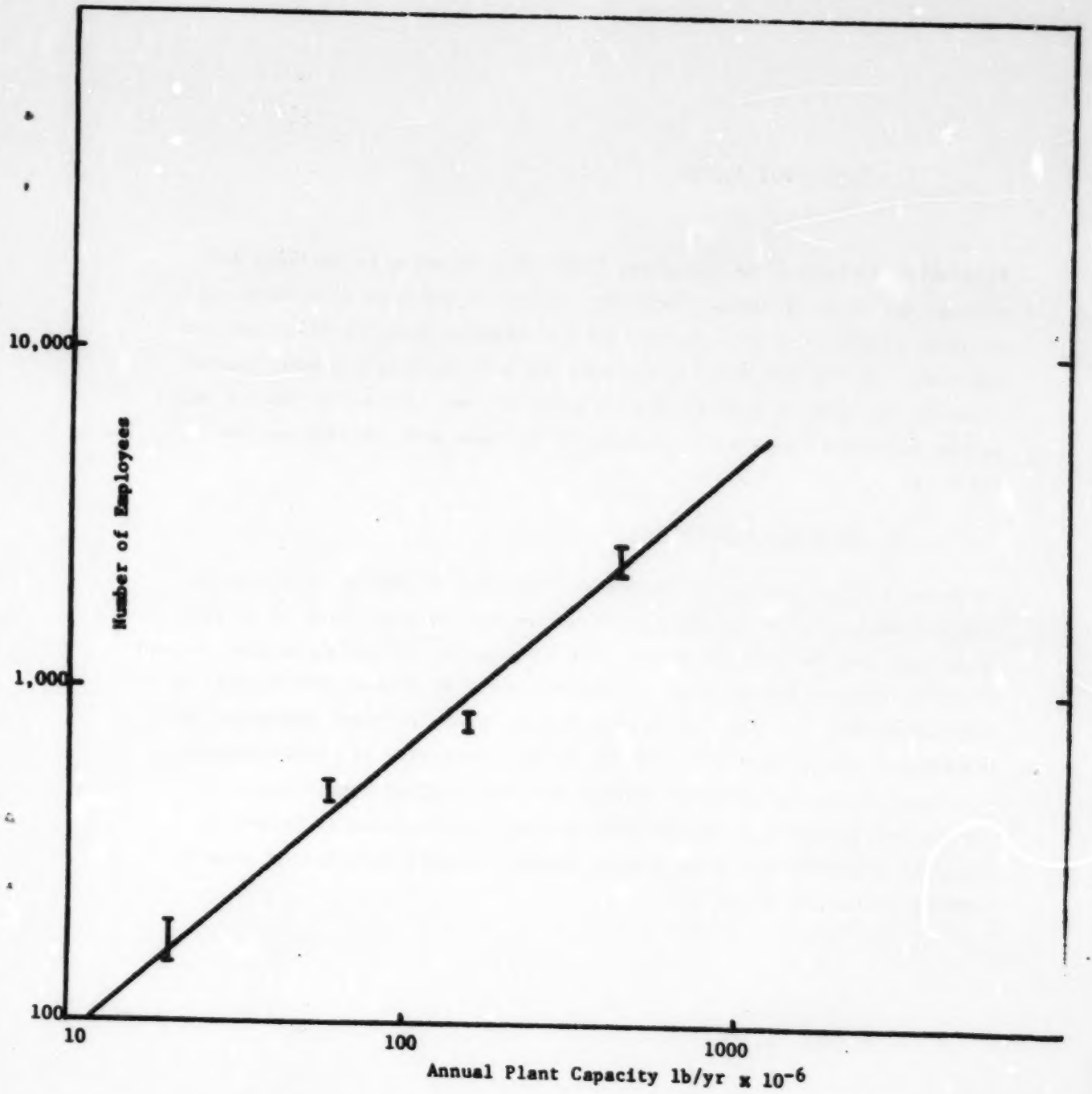


FIGURE 5 NUMBER OF EMPLOYEES IN THE GLASS WOOL INDUSTRY

2. Technology Trends

Processing technology in the glass fiber wool industry is unlikely to undergo any major changes. Improved throughput and high efficiency will no doubt result from more process control thereby reducing down time and improving quality control. New plants may well be single product operations producing high volume products such as home insulation. Direct melt-rotary spinner process will no doubt be utilized more broadly in the industry.

3. Capacity Utilization

Capacity Utilization in the wool glass industry is mostly sensitive to the variable rate of building construction and thus has been at an all-time high for the past 18 months. For example, it is estimated that current capacity utilization is close to maximum and that this condition will be maintained over the next two years, despite probable plant additions and expansions. Housing starts and the recent resurgency of non-residential construction has strengthened demand and the changing requirements for insulation in mobile homes and conventional construction (referred to earlier) will maintain this demand, despite a small anticipated drop in housing starts in 1973.

4. Degree of Competition and Competitive Practices

Despite the concentration of the glass fiber industry in the hands of only a few companies, the degree of competition displayed is healthy.

The four companies offering wool insulation compete actively on price and service and advertise widely and frequently. Basic profitability of the wool fiber glass sector, however, indicates that pricing is not entirely analogous to that for other commodity products responding to competition and reasonable margins are still enjoyed in relatively poor years.

5. Government Influence on the Supply of Glass Fiber

Two potential constraints on the supply of glass fiber exist: shortage of wrapping paper for shipments and shortage of gas energy. The second is potentially very serious and could limit production. The first constraint arises from the demise of many suppliers of these paper products (mainly due to pollution control and resulting profit problems) and the need of other suppliers to ration their producton. Although temporary, their shortage could result in a search for substitute wrappings.